1. A magnetic tunneling junction (MTJ) device in an MRAM configuration comprising:

a substrate;

a conducting lead layer formed on said substrate, the layer including a Ta capping layer having a sputter-etched upper surface;

an NiCr seed layer formed on said sputter-etched upper surface;

a bottom electrode formed on said seed layer, said bottom electrode further comprising:

a pinning layer of antiferromagnetic material;

an SyAP pinned layer formed on said pinning layer, said SyAP layer including lower and upper ferromagnetic layers magnetized in antiparallel directions, said upper and lower layers separated by a coupling layer;

an oxygen surfactant layer having been formed on said upper ferromagnetic layer;

a smooth, stoichiometrically homogeneous, tunneling barrier layer of oxidized aluminum having uniformly small grain size, formed on said oxygen surfactant layer and having absorbed the oxygen thereof;

a ferromagnetic free layer formed on said barrier layer;

a capping layer formed on said ferromagnetic free layer.

2. The device of claim 1 wherein said NiCr seed layer is formed of NiCr with there being between approximately 35%-45% Cr by number of atoms.

3. The device of claim 1 wherein the antiferromagnetic pinning layer is a layer of MnPt formed to a thickness of between approximately 100 and 200 angstroms or a layer of IrMn formed to a thickness between approximately 50 and 100 angstroms.

4. The device of claim 1 wherein the SyAP layer comprises a lower and upper layer of CoFe separated by a coupling layer of Ru, wherein at least the upper layer of CoFe, which is adjacent to the tunnel barrier layer, is CoFe(25%).

5. The device of claim 1 wherein the SyAP layer comprises a lower layer of CoFe and an upper composite layer of CoFe(10%)-NiFe(60%) separated by a coupling layer of Ru, wherein the upper composite layer is adjacent to the tunnel barrier layer.

6. The device of claim 4 wherein the lower layer of CoFe is between approximately 18 and 25 angstroms thick, the upper layer of CoFe is between approximately 15 to 20 angstroms thick and the Ru layer is 7 to 8 angstroms thick.

7. The device of claim 5 wherein the lower layer of CoFe is between approximately 18 and 25 angstroms thick, the upper composite layer of CoFe(10%)-NiFe(60%) is between approximately 5 and 10 angstroms thick, giving said composite layer a total magnetic thickness equivalent to 15 to 20 angstroms of CoFe(25%) and the Ru layer is 7 to 8 angstroms thick.

8. The device of claim 1 wherein the oxygen surfactant layer is less than a monolayer of oxygen adsorbed on the surface of said upper ferromagnetic layer.

9. The device of claim 4 wherein said upper ferromagnetic layer is CoFe(25%) and wherein the oxygen in said oxygen surfactant layer formed on said CoFe(25%) has been incorporated into said tunnel barrier layer.

10. The device of claim 5 wherein said upper ferromagnetic layer is a composite layer of CoFe(10%)-NiFe(60%) and wherein the oxygen in said oxygen surfactant layer has been incorporated into said tunnel barrier layer.

11. The device of claim 1 wherein the tunneling barrier layer is a layer of oxidized Al, formed by PVD deposition on an oxygen surfactant layer to a thickness between approximately 7 and 10 angstroms and oxidized by radical oxidation to a homogeneous Al_2O_3 stoichiometry.

12. The device of claim 1 wherein the ferromagnetic free layer is a bilayer of CoFe(25%)-NiFe(20%) in which the CoFe(25%) is formed to a thickness between approximately 5 and 10 angstroms and the NiFe(20%) is formed to a thickness between approximately 25 and 50 angstroms.

13. The device of claim 1 wherein the ferromagnetic free layer is a bilayer of NiFe(60%)-NiFe(20%) in which the NiFe(60%) is formed to a thickness between approximately 5 and 10 angstroms and the NiFe(20%) is formed to a thickness between approximately 25 and 50 angstroms.

14. A method of forming a magnetic tunneling junction (MTJ) MRAM device comprising:

providing a substrate;

forming, in a high vacuum deposition system, a bottom conductor layer on said substrate, said formation process further comprising:

forming a conducting lead layer on said substrate;

forming a Ta capping layer on said metal layer; and

sputter-etching said Ta capping layer;

forming, in the same high vacuum deposition system a lower pinned electrode, said formation further comprising:

forming an NiCr seed layer on said sputter-etched Ta layer;

forming, an AFM pinning layer on said seed layer;

forming a synthetic antiferromagnetic pinned (SyAP) layer on said pinning layer, said formation comprising a lower ferromagnetic layer formed on said pinning layer, a coupling layer formed on said lower ferromagnetic layer and an upper ferromagnetic layer formed on said coupling layer;

forming, in an oxidation chamber an oxygen surfactant layer on said upper ferromagnetic layer;

forming, a tunneling barrier layer on said oxygen surfactant layer, said formation further comprising:

forming, in said high vacuum deposition system, a layer of Al on said oxygen surfactant layer, said deposition first causing the adsorption of substantially all oxygen from said surfactant layer into said Al layer to form an amorphous layer of stoichiometric Al_2O_3 and, upon the depletion of all said oxygen in said surfactant layer, the remainder of said deposition forming a flat and smooth Al layer of small and uniform grain size; then

oxidizing said flat and smooth Al layer in a plasma oxidation chamber by a process of radical oxidation, said process forming from said flat and smooth Al layer an oxidized layer of stoichiometric Al_2O_3, said oxidized layer extending to said amorphous layer of stoichiometric Al_2O_3 formed during said Al deposition, to form, thereby, a tunneling barrier layer of substantially homogeneous Al_2O_3 stoichiometry; and

forming, in said high vacuum system a free layer on said tunneling barrier layer;

forming, in said high vacuum system an upper capping layer on said free layer;

annealing said MTJ MRAM device to magnetize said pinned layer, said annealing process further enhancing the Al_2O_3 stoichiometry of the tunneling barrier layer.

15. The method of claim 14 wherein said NiCr seed layer are formed of NiCr having 35%-45% Cr by number of atoms.

16. The method of claim 14 wherein the capping layer of Ta is formed to a thickness between approximately 80 and 100 angstroms and is sputter etched in a process to remove between approximately 20 and 30 angstroms of said Ta layer.

17. The method of claim 14 wherein the antiferromagnetic pinning layer is formed as a layer of MnPt to a thickness between 100 and 200 angstroms or a layer of IrMn formed to a thickness between 50 and 100 angstroms.

18. The method of claim 14 wherein the SyAP layer is formed as a lower and upper layer of CoFe separated by a layer of Ru and wherein at least the upper CoFe layer, which is adjacent to said tunnel barrier layer, is CoFe(25%).

19. The method of claim 14 wherein the SyAP layer is formed as a lower layer of CoFe and an upper composite layer of CoFe(10%)-NiFe(60%) separated by a coupling layer of Ru, wherein the upper composite layer is adjacent to the tunnel barrier layer.

20. The method of claim 18 wherein the lower layer of CoFe is formed between approximately 18 and 25 angstroms thick, the upper layer of CoFe is formed between approximately 15 and 20 angstroms thick and the Ru layer is formed between approximately 7 and 8 angstroms thick.

21. The method of claim 19 wherein the lower layer of CoFe is formed between approximately 18 and 25 angstroms thick, the upper composite layer of CoFe(10%)-NiFe(60%) is formed with the NiFe(60%) being between approximately 5 and 10 angstroms thick, giving said composite layer a total magnetic thickness equivalent to 15 to 20 angstroms of CoFe(25%) and the Ru layer is formed between approximately 7 and 8 angstroms thick.

22. The method of claim 14 wherein the process of forming an oxygen surfactant layer on said second ferromagnetic layer further comprises introducing oxygen into said oxidation chamber at a rate of between 0.02 and 0.04 sccm to purge said chamber with oxygen gas at approximately $2x10^{-7}$ torr pressure and leaving the layer in the oxidation chamber for approximately 2 minutes.

23. The method of claim 14 wherein the process of forming an oxygen surfactant layer on said second ferromagnetic layer further comprises sputtering said layer with argon atoms in an oxygen ambient wherein the sputtering chamber maintains a base pressure of approximately $5x10^{-9}$ torr and said ultra-low pressure Ar/O_2 mixture is produced by mixing an ultra-low pressure source of high purity Ar containing oxygen in an amount less than 0.5 ppm, with the same Ar source to which between approximately 400 and 600 ppm of oxygen has been admixed, said high purity Ar being at an approximate pressure of 0.4 millitorr and said oxygen having therein a partial pressure of between approximately 10^{-9} and 10^{-8} torr.

24. The method of claim 14 wherein said radical oxidation process further comprises:

feeding 0.5 liters of oxygen gas to an ionizing electrode within a plasma chamber;

partially ionizing said oxygen at an electrode supplied with between approximately 500-800 watts of power;

passing said partially ionized gas through a grid to produce a shower of oxygen species comprising oxygen molecules, atoms, ions and radicals;

directing said shower at said Al layer being oxidized.

25. The method of claim 14 wherein the ferromagnetic free layer is formed as a bilayer of CoFe(25%)-NiFe(20%) in which the CoFe(25%) is formed to a thickness between approximately 5 and 10 angstroms and the NiFe(20%) is formed to a thickness between approximately 25 and 50 angstroms.

26. The method of claim 14 wherein the ferromagnetic free layer is formed as a bilayer of NiFe(60%)-NiFe(20%) in which the NiFe(60%) is formed to a thickness between approximately 5 and 10 angstroms and the NiFe(20%) is formed to a thickness between approximately 25 and 50 angstroms.